

WHAT IS CLAIMED IS:

1. An automatic brake device, comprising:

a braking-force application unit that applies a braking force on a wheel of a vehicle on the basis of a brake actuating signal;

an intended direction detecting unit that detects an intended movement direction in which a driver intends to move the vehicle;

a starting intention detecting unit that detects an operation input based on a starting intention of the driver;

a movement direction detecting unit that detects an actual movement direction of the vehicle; and

a brake control unit that outputs the brake actuating signal, wherein

the brake control unit executes a halt-maintenance mode for driving the braking-force application unit for application of a halt-maintenance braking force on the wheel to maintain the vehicle in a halted state,

a movement direction detection mode for terminating the halt-maintenance mode at a time when the starting intention detecting unit detects the starting intention of the driver, and for receiving input of the actual movement direction from the movement direction detecting unit, and

an auxiliary brake mode for outputting the brake actuating signal for controlling the braking force on the basis of a relationship between the intended movement

direction detected by the intended direction detecting unit and the actual movement direction.

2. The automatic brake device according to claim 1, wherein

the intended direction detecting unit is a shift position sensor detecting the intended movement direction of the driver from a shift position of a transmission of the vehicle, and

the starting intention detecting unit is an accelerator pedal operation amount sensor detecting an amount of operation of an accelerator pedal of the vehicle that is input by the driver.

3. The automatic brake device according to claim 1, wherein the movement direction detecting unit detects, as the actual movement direction, a direction in which the vehicle moves when the braking force is decreased at a predetermined initial pressure decrease gradient until the braking force is lower than the halt-maintenance braking force in the halt-maintenance mode.

4. The automatic brake device according to claim 3, wherein the movement direction detecting unit determines the initial pressure decrease gradient on the basis of a magnitude proportional to a product of the halt-maintenance braking force and at least one of a physical

quantity representing the degree of the starting intention and a duration of operation of the initial pressure decrease.

5. The automatic brake device according to claim 1, wherein the movement direction detecting unit detects the actual movement direction on the basis of a speed signal of the wheel of the vehicle.

6. The automatic brake device according to claim 1, wherein in the auxiliary brake mode, when the intended movement direction is opposite to the actual movement direction, the brake control unit executes a first opposite mode for outputting the brake actuating signal so as to increase the braking force at a predetermine increase gradient.

7. The automatic brake device according to claim 6, wherein in the first opposite direction mode, when a movement speed of the vehicle is equal to or higher than a preset target speed, the brake control unit sets the increase gradient for the braking force to be higher in accordance with a deviation between the movement speed of the vehicle and the target speed.

8. The automatic brake device according to claim 1, wherein in the auxiliary brake mode, when the intended

movement direction is opposite to the actual movement direction, the brake control unit executes a first opposite direction mode for controlling the braking force by feedback control in order to bring a movement speed of the vehicle in line with a preset target speed.

9. The automatic brake device according to claim 3, wherein in the auxiliary brake mode, the brake control unit stores, as a start-of-movement braking force, the braking force at time when the vehicle starts to move due to decrease of the braking force at the initial pressure decrease gradient, and further, when the intended movement direction is opposite to the actual movement direction, the brake control unit executes a second opposite direction mode for outputting the brake actuating signal for increasing the braking force such that the braking forces becomes equivalent to the start-of-movement braking force.

10. The automatic brake device according to claim 1, wherein in the auxiliary brake mode, when the intended movement direction is opposite to the actual movement direction,

the brake control unit executes a first opposite direction mode for outputting the brake actuating signal for increasing the braking force at a predetermined increase gradient when a movement distance in the actual

movement direction is equal to or smaller than a preset amount of target movement, and

when the movement distance in the actual movement direction exceeds the preset amount of target movement, the brake control unit stores, as a start-of-movement braking force, the braking force at a time when the vehicle starts to move due to decrease of the braking force at the initial pressure decrease gradient, and when the intended movement direction is opposite to the actual movement direction, the brake control unit executes a second opposite direction mode for outputting the brake actuating signal for increasing the braking force such that the braking force becomes equivalent to the start-of-movement braking force.

11. The automatic brake device according to claim 1, wherein in the auxiliary brake mode, when the intended movement direction is opposite to the actual movement direction,

the brake control unit executes a first opposite direction mode for outputting the brake actuating signal for increasing the braking force at a predetermined increase gradient when a number of experiences of movement of the vehicle in the same direction as the intended movement direction is smaller than a predetermined number, and

when the number of experiences of movement of the vehicle in the same direction as the intended movement direction exceeds the predetermined number, the brake control unit stores, as a start-of-movement braking force, the braking force at a time when the vehicle starts to move due to decrease of the braking force at the initial pressure decrease gradient, and when the intended movement direction is opposite to the actual movement direction, the brake control unit executes a second opposite direction mode for outputting the brake actuating signal for increasing the braking force such that the braking force becomes equivalent to the start-of-movement braking force.

12. The automatic brake device according to claim 1, wherein in the auxiliary brake mode, when the intended movement direction is the same as the actual movement direction, the brake control unit executes a same direction mode for outputting the brake actuating signal for decreasing the braking force at a predetermined decrease gradient.

13. The automatic brake device according to claim 12, wherein the brake control unit determines the decrease gradient for the braking force in the same direction mode on the basis of at least one of an amount of accelerator

pedal operation detected by the starting intention detecting unit, and a movement speed and a movement acceleration in the actual movement direction detected by the movement direction detecting unit.

14. An automatic brake device, comprising:

a braking-force application unit including a first brake unit that generates a first braking force on each wheel of a vehicle on the basis of a first actuating signal, and that changes the first braking force to zero when output of the first actuating signal is stopped, and a second brake unit for generating a second braking force on at least one of the wheels of the vehicle on the basis of a second actuating signal, and for, when output of the second actuating signal is stopped, maintaining the second braking force at a value of an active state based on the second actuating signal before the output of the second actuating signal is stopped;

a starting preparation intention detecting unit that detects an operation input based on an intention of the driver to prepare for starting of the vehicle,

an intended direction detecting unit that detects an intended movement direction in which the driver intends to move the vehicle,

a movement direction detecting unit that detects an actual movement direction of the vehicle,

a brake control unit that, when the second braking force applied by the second brake unit maintains the vehicle in a halted state, switches the braking force applied to the wheels from the second braking force to the first braking force when the operation input representing the intention of the driver to prepare for starting is detected, and outputs the first actuating signal and the second actuating signal such that the first braking force is applied in accordance with a relationship between the detected intended movement direction and the actual movement direction.

15. The automatic brake device according to claim 14, wherein the starting preparation intention detecting unit detects any one of three operations that are an actuation of a starting-preparation completion switch, shifting of a shift position of a transmission, and an actuation of a brake operation switch.

16. An automatic brake device, comprising:

a braking-force application unit including a first brake unit that generates a first braking force on each wheel of a vehicle on the basis of a first actuating signal and changes the first braking force to zero when output of the first actuating signal is stopped, and a second brake unit for generating a second braking force on at least one of the wheels of the vehicle on the basis of



a second actuating signal, and for, when output of the second actuating signal is stopped, maintaining the second braking force at a value of an active state based on the second actuating signal before the output of the second actuating signal is stopped;

a starting intention detecting unit that detects an operation input based on an intention of the driver for the vehicle to start;

an intended direction detecting unit for detecting an intended movement direction in which the driver intends to move the vehicle;

a movement direction detecting unit for detecting an actual movement direction of the vehicle; and

a brake control unit that, when the second braking force applied by the second brake unit maintains the vehicle in a halted state, removes the second braking force in the halt-maintenance state in accordance with the operation input based on the detected intention of the driver to start, and further, when the actual movement direction of the vehicle differs from the intended movement direction, outputs the first actuating signal and the second actuating signal such that the first braking force is applied to the wheels when either a movement speed of the vehicle exceeds a predetermined speed, or when an amount of movement of the vehicle exceeds a predetermined value.

17. An automatic brake device, comprising:

a braking-force application unit that applies a braking force on a wheel of a vehicle on the basis of a brake actuating signal;

an intended direction detecting unit that detects an intended movement direction in which a driver intends to move the vehicle;

a movement direction detecting unit that detects an actual movement direction of the vehicle; and

a brake control unit that applies the brake actuating signal to the braking-force application unit in accordance with a relationship between the detected intended movement direction and the actual movement direction, in order to control the braking force.

18. An automatic brake device, comprising:

a braking-force application unit that applies a braking force on a wheel of a vehicle on the basis of a brake actuating signal;

an intended direction detecting unit that detects an intended movement direction in which a driver intends to move the vehicle;

a movement direction detecting unit that detects an actual movement direction of the vehicle; and

a brake control unit that applies the brake actuating signal to the braking-force application unit in order to increase the braking force such that the braking force

exceeds the braking force at a time of detecting the actual movement direction, when the detected intended movement direction is opposite to the actual movement direction.

19. The automatic brake device according to claim 18, wherein the brake control unit outputs the brake actuating signal to remove the braking force when the intended movement direction and the actual movement direction are not opposite to each other.